Characteristic features of the vegetation cover around the Yenikend reservoir (Lesser Caucasus within Azerbaijan)

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Abstract: The article analyzes the vegetation around the Yenikend reservoir within a radius of 2500 m. Natural vegetation types and anthropogenic objects (agrophytocenoses and settlements) were deciphered by us using remote sensing (RSM). During the study, five types of natural vegetation were identified including semi-desert vegetation, wetland vegetation, shrub vegetation, oasis vegetation, forest vegetation (in the form of remains) and two anthropogenic objects such as agrophytocenoses and residential areas. Based on the geobotanical study of the vegetation of the area, four types (semi-desert, bush, wetland, oasis), four formation classes, eight formation groups, eight formations and 21 associations were determined. The classification of vegetation cover was developed by studying their distribution, species composition and the relationship between structural components, the coenosis-forming, dominant and subdominant species, as well as edificators and subedificators were determined in existing types of vegetation.

Keywords: *anthropogenic plant objects, interpretation, remote sensing, types of vegetation*

INTRODUCTION

The study of the vegetation cover as a component of the geographical landscape is a prerequisite for the implementation of the most important problem on a global scale such as the preservation of biological diversity. One of the components of these studies is a comprehensive study of coenofloras and their spatial distribution in a particular territory, depending on many environmental factors (geographic location, relief, climate, the nature of moisture, etc). Studying the plant cover is crucial in this regard since it shows strong azonality and is impacted by the island effect, which causes some species' ranges to diverge and phytocenoses to become ecologically isolated [Astamirova et al. 2021]. Vegetation is an important component of terrestrial ecosystems and plays an irreplaceable role in global material and energy cycling, regulating carbon balance, and maintaining climate stability, as well as an "indicator" of global ecosystem changes. Vegetation dynamics in arid and semi-arid regions have an important impact on carbon cycle, water cycle, and energy exchange at local, regional, and global scales. Therefore, it is of great significance for scientists to grasp the changes of vegetation cover in arid and semi-arid regions timely and accurately [Zhihong Liu et al., 2022].

The study of current flora and vegetation of specific areas, the determination of changes there, and the conduct of studies against the background of environmental, anthropogenic and zoogenic influences are of greater importance, both theoretically and experimentally. One of such unique areas is Yenikend reservoir located in Shamkir district in the northern part of the Lesser Caucasus (LC). The biogeographic region has a continuously developing area of geographical environment [Abdurahmanov, 2019]. The territory of Yenikend water basin is connected to the Kura River, the Ganjachay and Goshgarchay valleys. The frequent rise and fall of water here and other anthropogenic impacts have led to the washing of slopes, increased erosion processes, and changes in the composition, structure and productivity of flora and vegetation [Ibadullayeva et al., 2016; Sadigova et al., 2023]. The goal set is the study of the current state of vegetation cover in the surrounding areas of Yenikend water basin, drawing up a general GIS map (with QGIS software) and decoding the types of vegetation existing in the area by the method of Earth Remote Sensing (ERS).

MATERIAL AND METHODS

During the research, short and long-term field trips were carried out to the basin area in the spring, summer and

autumn seasons of 2022-2023 [Sadigova, 2016]. The studies were mainly carried out by semi-stationary and stationary methods, the geobotanical notes regarding structure of phytocoenoses were made, herbarium materials were collected and photographs of formations were taken separately. Generally accepted methodology in current field geobotanical research [Lavronko, 1959; Mehdiyeva, 2017; Meth..., 1938; Mirkin, 2001; Pedrotti, 2013; Shennikov, 1964; Yaroshenko, 1969 and etc.] were applied.

Vegetation units were determined based on the dominant-determinant approach and generally accepted ecological-phytocoenotic methods [Movsumova, 2005; Neshateyev, 2001]. The main hierarchical ranks of this system include vegetation types, formation classes, formation groups, formations and associations, which is the smallest unit of the existing system. Vegetation type is the highest classification unit and represents a set of plant communities united into formations and their classes based on life forms or structural and ecological characteristics of dominant species [Whittaker, 1962]. As it is known, formation is a union of several associations with one similar dominant or edificator species, association is a union of phytocoenoses with a similar dominant composition, vertical and horizontal structure and habitat. Dominant species are those that prevail or dominate at the main tiers of phytocoenoses, and edificators are plants that form the basis of phytocoenoses and play a key role in creating on environment (lighting regime, humidity, etc.).

The GIS map of the studied area [Avkhadieva, 2019; Andreyev, 2020; NextGIS 2024], as well as the remote sensing of vegetation types [Shikhov, 2020] were compiled using QGIS [QGIS software, 2016].

RESULTS

Based on the specified GPS coordinates, the boundaries, forest and water polygons of the research area were described and GIS map was compiled (Fig. 1).

Vegetation types of the area studied by Earth Remote Sensing, as well as agrophytocoenoses and residential areas were analyzed and the data was decoded. Based on the geobotanical study of the vegetation of the area, four types (semi-desert, shrub, wetland, oasis), four formation classes, eight formation groups, eight formations and 21 associations were found. As a result of
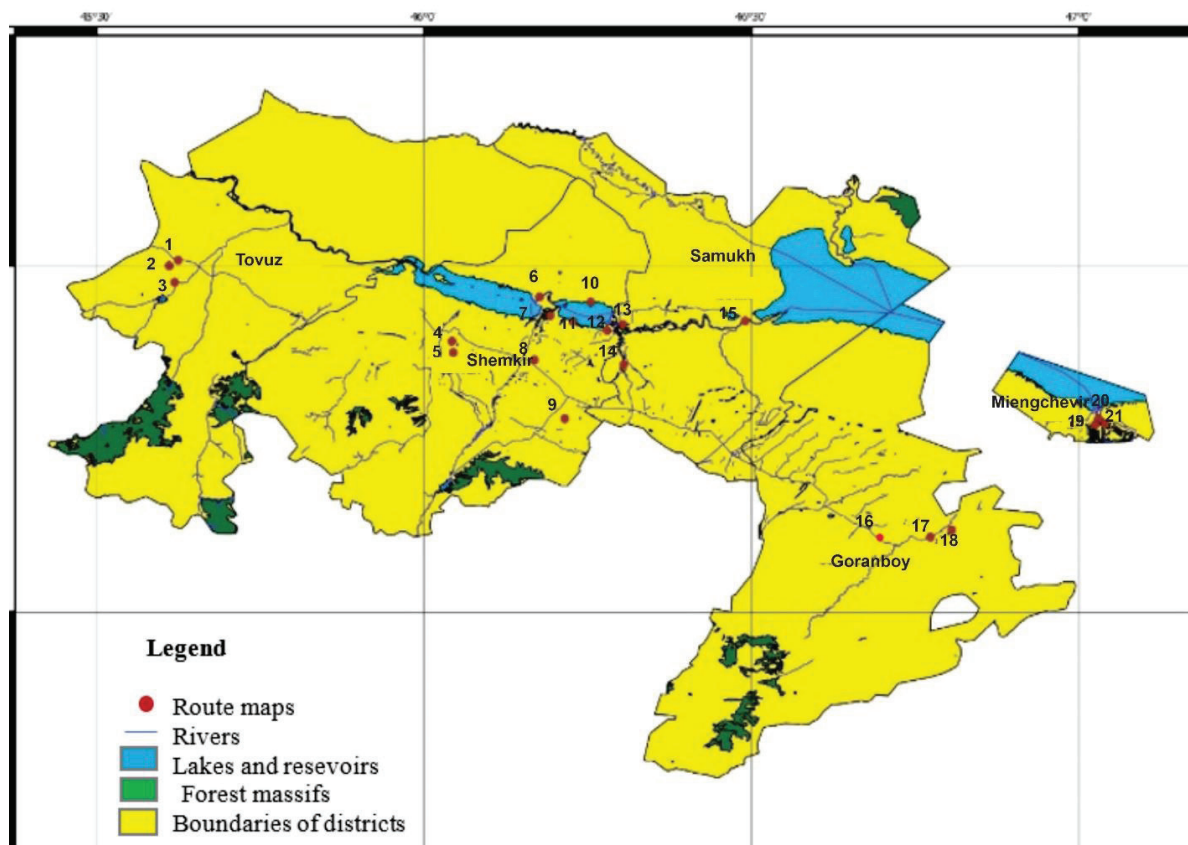

Figure 1. Map of the Yenikend reservoir and surrounded districts: 1-3. Tovuz, 4-12. Shamkir, 13-15. Samukh, 16-18. Goranboy, 19-21. Mingachevir.

the research, it was determined that the main vegetation type of the area in current conditions is wormwood (*Artemiseta*) semi-deserts. Phytocoenoses previously dominated by meadow and steppe plants, are now observed as small spots or in mixed form with saltworts. In this type of vegetation, sinkhole-meadow groupings were observed fragmentarily (Fig. 2). Wormwoods formed with the participation of ephemerals, saltworts and capers are widespread here.

As a result of the geobotanical studies, it was determined that the plants which are background and edificator for the semi-desert vegetation type (Fig. 2) are *Artemisia szowitsiana* (Besser) Grossh. and *A. fragrans* Willd. species and subedificator is *Alhagi psedoalhagi* (M. Bieb.) Desv. ex Shap. and *Peganum harmala* L. species. On the basis of geobotanical descriptions and observations, the main elements of semi-deserts in the flora are determined and shown in the following sequence (Tab. 1).

Shrub vegetation (Fig. 2) in the form of a mixture of herbs and shrubs is ecologically close to forest and meadow vegetation appears in some areas, especially in the southern directions of the slopes, on rocks and steeps, accepting xerophytic elements, in forest surrounding areas, close to meadows or in small areas in a mixed

form, and sometimes in clearings in mesophytic form. Shrubs associated with xerophytic plants also have a general similarity with steppe groupings (Fig. 2). Shrub vegetation is distributed in the area as evergreen and deciduous plant formation in the xeromesophyte form, and deciduous shrub plant formation in the mesophytic
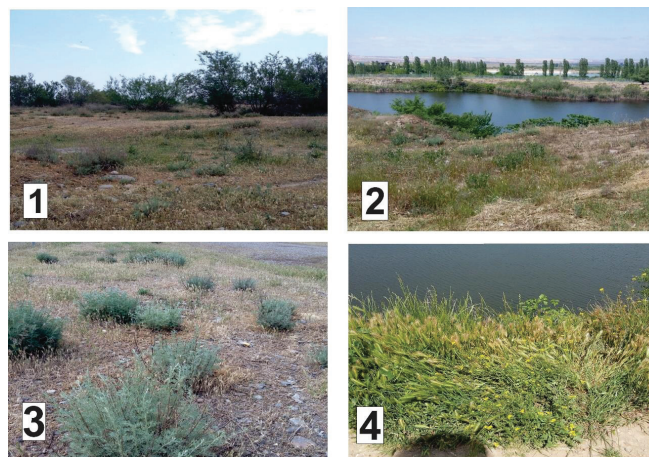

Figure 2. Vegetation types: 1. shrub vegetation (with the abundance of *Tamarix meyeri*, *T. hohenackeri*), 2. wetland vegetation, 3. wormwood-ephemerals, 4. oasis vegetation.

Table 1. Semi-desert vegetation units found around Yenikend reservoir.

Vegetation rank	Vegetation units
Formation class	Semi-shrub and herb deserts
Formation group	*Artemiseta*
Formation	*Artemiseta fragrans*
	Artemisia fragrans (monoassociation).
	Artemisia fragrans + Ephemerae.
Association	*Artemisia fragrans+Alhagi pseudoalhagi.*
	Artemisia fragrans+ Capparis spinosa
	Artemisia fragrans+ Salsola dendroides + Ephemerae
Formation class	Herb semi-desert
Formation group	*Alhageta*
Formation	*Alhageta psedoalhagi*
	Alhagi psedoalhagi (monoassociation).
Association	*Alhagi psedoalhagi + Salsola dendroides+ Ephemerae*
	Alhagi psedoalhagi + Ephemerae
Formation group	*Peganeta harmalae*
Formation	*Peganeta harmalae*
Association	*Peganum harmala+Ephemerae*
	Peganum harmala+Capparis spinosa
Formation class	Herb - shrub semi-desert
Formation group	*Tamarixeta*
Formation	*Tamarixeta hohenackeri*
Association	*Tamarix hohenackeri+ Tamarix meyeri (including forb)*
	Tamarix hohenackeri+Artemisia szowitsiana + Artemisia fragrans

form. Shrubs spread on the slopes of the basin. Dominant shrub vegetation type was identified as *Tamarix meyeri* Boiss., and subdominant as *Juniperus exselsa* Bieb. species. The classification of shrub vegetation in the area is given based on geobotanical descriptions (Tab. 2).

Wetland vegetation (Fig. 2) is distributed around Yenikend reservoir, as well as along the banks of the Kura River and its tributaries passing through the area, around ponds and standing water. Here, the species *Phragmites australis* (Cav.) Trin. ex Steud. and *Potamogeton crispus* L. create the background and act as edificators. The species *Carex vesicaria* L., *Bolboshoenus maritimus* (L.) Palla, *Puccinellia gigantea* (Grossh.) Grossh, *Typha latifolia* L., *Phragmites australis* (Cav.) Trin. ex Steud can be considered coenosis-forming in this type of vegetation (Fig. 2).

During the field studies, the plant units were described in wetland vegetation (Tab. 3). Oasis vegetation (Fig. 2) is widespread in the basin from the plains to the low mountain belt. It contain trees and shrubs such as *Platanus orientalis* L., *Juglans regia* L., *Populus gracilis* Grossh., *Salix alba* L., *Ulmus scabra* Mill., *Prunus divaricata* Ledeb., *P. domestica* subsp. *cerasiferoflora* Vitk., *Elaeagnus angustifolia* Blanco,

Pyrus communis auct.iber, *Rubus caesius* Thunb. etc., perennial grasses such as *Onobrychis transcaucasica* Grossh., *Hordeum bulbosum* L., *Trifolium pratense* L., *Vicia sativa* L., *Symphytum asperum* Lepech., *Falcaria vulgaris* Bernh., *Geumrivale* auct., *Melilotus officinalis* L. Pall., *Agrimonia eupatoria* Michx. etc., as well as inedible, harmful and poisonous species. The distribution of species in this vegetation is diffuse, and dominant species are not selected by abundance. For this reason, it was not possible to determine the plant units. Successions are also observed in this vegetation. Thus, in the place of remnant Tugai forests individual representatives are observed.

Agrophytocenoses are cultivated plantings of barley, wheat, corn, sugar beets, potatoes, sunflowers, grapes, forage plants such as alfalfa, sainfoin and vegetable garden beds. Weed plants such as *Cynodon dactylon* (L.) Pers., *Convolvulus arvensis* L., *Acroptilon repens* (L.) DC., *Tribulus terrestris* Muhl., *Solanum nigrum* L., *Lactuca serriola* L., *Plantago lanceolata* L., *Sorghum halapense* (L.) Pers., *Galinsoga parviflora* Cav., *Euphorbia humifusa* Willd. etc. are observed. In recent years, the activation of the species *Xanthium strumarium* L., *X. spinosum* L., *Amaranthus retroflexus*

Table 2. Shrub vegetation units found around Yenikend reservoir.

Vegetation rank	Vegetation units
Formation class	Coniferous, broad-leaved mixed shrub, semi-shrub, herb (*herbosa*)
Formation group	*Junipereta*
Formation	*Junipereta exselsa* subsp. *policarpos*
Association	*Juniperus exselsa subsp. Polycarpos+Berberis vulgaris+Herbosa*
Formation class	Broad-leaved shrub, semi-shrub, herbs
Formation group	*Tamarixeta*
Formation	*Tamarixeta meyeri*
Association	*Tamarix meyeri + Tamarix hohenackeri (with the participation of herbs)* *Artemisia szowitsiana + Artemisia fragrans+Tamarix hohenackeri*

Table 3. Wetland vegetation units found around Yenikend reservoir.

Vegetation rank	Vegetation units
Formation class	Fully and partially submerged herbs
Formation group	*Phragmiteta*
Formation	*Phragmiteta australis*
Association	*Phragmites australis+Thypha longifolia-Herbosa* *Phragmites australis-Herbosa*; *Phragmites australis+ Eleocharis palustris* *Phragmites australis+ Lemna minor* *Phragmites australis + Potamogeton nodosus+ Persicaria hydropiper*
Formation group	*Potamagineta*
Formation	*Potamagineta crispus*
Association	*Potamogeton crispus+Zannichelia palustris*

L., *Chenopodium album* L. has been observed in this type of phytocoenoses.

One of the important conditions for mapping regional land cover is the clarification of existing territorial plant communities. Therefore, the potential greenness (in terms of vegetation) can be predicted by combining common classification features and studying the modelling and accuracy of biophysical parameters in the areas where the process occurs. For this purpose, natural vegetation types and agrophytocoenoses and residential areas that we have already given extensive information were decoded during the research. For this, a Bing satellite map of the studied area was obtained using SAS [2007-2023]. By using Planet software, based on the obtained map information, the vegetation types of the area were decoded.

During the decoding, five types of natural vegetation were identified: semi-desert, wetland, shrub, oasis, forest (in the form of remains) and two anthropogenic objects: agrophytocenoses and residential areas. The buffer zone within a radius of 2500 m from the coastline of Yenikend reservoir was chosen as the basis for decoding (Fig. 3). The maps obtained by the method of Earth Remote Sensing were decoded using QGIS software [QGIS, 2016].

In developing the layout of the decoded area, samples of vegetation types taken by the Bing satellite were reflected in the project in the form of photo fragments. The layout is equipped with a size ruler, side marking (N) and a legend.

The results obtained as a result of decoding are reflected in the table of attributes, respectively (Tab. 4).

The complementarity of water and desert elements over such a large area may become a very important factor in the future, capable of stimulating the transition of a number of species of xerophytic origin to mesoxerophytic vegetation types by changing their habitat over time. For this reason that a number of species such as *A. fragrans* Eichw., *A. szowisiana* (Besser) Grossh. have started to adapt from the
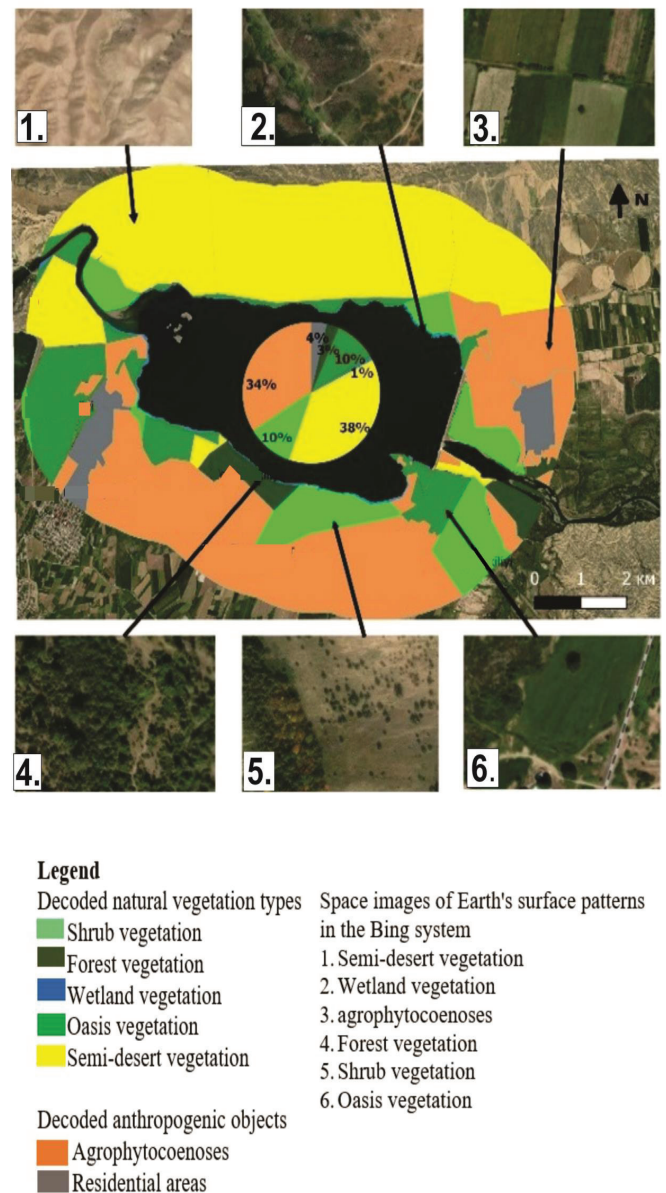

Legend

Decoded natural vegetation types
- Shrub vegetation
- Forest vegetation
- Wetland vegetation
- Oasis vegetation
- Semi-desert vegetation

Space images of Earth's surface patterns in the Bing system
1. Semi-desert vegetation
2. Wetland vegetation
3. agrophytocoenoses
4. Forest vegetation
5. Shrub vegetation
6. Oasis vegetation

Decoded anthropogenic objects
- Agrophytocoenoses
- Residential areas

Figure 3. Decoded map-scheme of the buffer zone taken in a radius of 2500 m of Yenikend reservoir basin.

Table 4. Quantitative indicators of decoded areas according to vegetation types.

Vegetation types	Area (ha)	Area (%)
Semi-desert vegetation	2548,3670	38,04
Wetland vegetation	56,8254	0,85
Shrub vegetation	701,4291	10,47
Oasis vegetation	669,4918	9,99
Forest vegetation	189,9578	2,84
Residential areas	243,1315	3,63
Agrophytocenoses	2289,3670	34,18

xerophyte position they occupy in the ecological groups to the mesoxerophytes. Based on the data obtained as a result of decoding, a diagram was developed and placed on the decoding layout accordingly. The diagram is drawn according to the colors in which vegetation types and anthropogenic objects are shown in the natural decoding layout.

CONCLUSION

Thus, one formation class, three formation groups, three formations and 10 associations are typical for the semi-desert vegetation type of the studied area. Shrub vegetation type existing in the area includes two formation classes, two formation groups, two formations and three associations. Wetland vegetation type includes one formation class, two formation groups, two formations and five associations. The distribution of species found in the oasis vegetation type is diffuse, and dominant species are not selected by abundance.

Agrophytocoenoses are irrigated from the basin. It is difficult to conduct natural vegetation research due to the increased number of farms. Depending on such anthropogenic effects, the natural cover of phytocenoses can change to a great extent.

As a result of decoding based on the method of Earth Remote Sensing, it was found that semi-desert vegetation from natural vegetation types, and agrophytocenoses from anthropogenic objects make up 72.22% of the total area. Shrub and oasis vegetation each separately cover approximately 10% of the total area. Wetland vegetation is located mainly on the shoreline of the reservoir and occupies 0.85% of the total area.

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Yenikənd su anbarı ətrafı bitki örtüyünün səciyyəvi xüsusiyyətləri (Azərbaycan hüdudlarında Kiçik Qafqaz)

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Məqalədə Yenikənd su anbarının 2500 m radiusda bitkiliyi təhlil edilmişdir. Təbii bitkilik tipləri və antropogen obyektlər (aqrofitosenozlar və yaşayış məntəqələri) tərəfimizdən məsafədən zondlama metodu ilə (MZM) deşifrə edilmişdir. Tədqiqat zamanı yarımsəhra bitkiliyi, su-bataqlıq bitkiliyi, kol bitkiliyi, vahə bitkiliyi, meşə bitkiliyi (qalıqlar şəklində) kimi beş təbii bitkilik tipi və aqrofitosenozlar və yaşayış məntəqələri kimi iki antropogen obyekt müəyyən edilmişdir. Ərazinin bitkiliyinin geobotaniki tədqiqinə əsasən dörd tip (yarımsəhra, kolluq, su-bataqlıq, vahə), dörd formasiya sinfi, səkkiz formasiya qrupu, səkkiz formasiya və 21 assosiasiya müəyyən edilmişdir. Təsnifat işlənib hazırlanmış, yayılması, növ tərkibi, quruluşu, komponentləri arasındakı qarşılıqlı əlaqələr tədqiq edilməklə, mövcud bitkilik tiplərində senozəmələgətiricilər, dominant və subdominant növlər, eləcə də edifikator və subedifikatorlar müəyyən edilmişdir.

Açar sözlər: *antropogen bitki obyektləri, təfsir, məsafədən zondlama, bitkilik tipləri*

Характерные особенности растительного покрова в окрестностях Еникендского водохранилища (Малый Кавказ в пределах Азербайджана)

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В статье проанализированы типы растительности вокруг Еникендского водохранилища (в радиусе 2500 м). Естественные типы растительности и антропогенные объекты (агрофитоценозы и поселения) расшифрованы нами с помощью дистанционного зондирования (ДЗЗ). При расшифровке выявлено пять типов естественной растительности: полупустынная растительность, болотная растительность, кустарниковая растительность, оазисная растительность, лесная растительность (в виде остатков) и два антропогенных объекта: агрофитоценозы и поселения. На основе геоботанического изучения растительности территории путем изучения взаимоотношений в существующих выделено

четыре типа (полупустыня, кустарник, заболоченная местность, оазис), четыре класса формаций, восемь групп формаций, восемь формаций и 21 ассоциация. Классификация была разработана путем изучения их распространения, видового состава и соотношения между структурными компонентами, ценозообразующими доминирующими и субдоминантными видами, а также определены эдификаторы и субэдификаторы в существующих типах растительности..